Response to Reviewers: 17120111-G Adult Pacific Herring Acoustic Surveys, P.I. Rand

This proposal was well-written and the objectives are very clearly stated: “to continue a long term data set of biomass estimates of the spawning population of Pacific herring in Prince William Sound.” This proposal primarily addresses Objectives 1 (expanding and testing the herring ASA model) and 2 (providing input to the ASA model). Since 1993, the Prince William Sound Science Center (PWSSC) has been carrying out acoustic surveys as a cost-effective approach to estimate the biomass of adult Pacific herring just prior to the spawning period. The stated goal is to “produce a reliable estimate of adult biomass of the spawning population of Pacific herring for each year during 2017-2021 in support of the age-structured assessment (ASA) model”.

The Panel notes that this work provides essential information for the herring assessment model, and for this reason the work should continue as proposed. We also note and commend the PI for ensuring that the continuity of this work will continue as it has been conducted in the past.

The Panel has several concerns and comments, however, one of which was mentioned in the response to the Moffitt proposal. That is, there is not a readily accessible database of the past acoustic surveys. Ideally there should have been annual reports showing dates and time and location of surveys, and locations where herring were, and were not, found. As much as possible these last surveys should also have commented on any issues (technical, methodological or biological) related to species identification and other factors that might have affected that validity of the data. In lieu of this and in recognition of the vital importance of these past acoustics data to the herring assessment process, the Panel recommends that a quantitative synopsis of past work be prepared, as an essential element in the assessment process.

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PI Response:

I definitely recognized the value of documenting past observations. Much has been documented in annual reports submitted by the PI in the past (Dick Thorne at the PWSSC); however, I do acknowledge the difficulty of extracting insight into interannual trends and patterns by reviewing these reports. I have received a draft manuscript authored by Dick Thorne that summarizes the acoustic monitoring efforts in Prince William Sound from 1993-2015. In annual reports during this grant cycle, I will provide a brief summary of the current year’s data as well as some historic context in the form of trends in annual biomass. Any notable changes from year to year in the herring distribution based on the acoustic survey will also be highlighted. I added a few sentences at the end of the executive summary in the revised proposal highlighting these efforts at better reporting. The PI has also been working with Axiom to make sure all the raw, digital files of acoustic data are now available on the AOOS HRM data portal (starting with year 2000).

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Further, the Panel appreciated the comments on target strength of herring but also notes that there have been changes in size-at-age, and perhaps condition of PWS herring during the past several decades. Could such changes affect target strength? Perhaps there have been other changes? Therefore we wonder how such changes in the physical and biotic environment would have affected estimates of herring biomass. Clearly there may be other concerns about acoustic work as reliable indicators of herring biomass. In view of such uncertainties, the Panel encourages the PI to take a more rigorous and critical approach to acoustic assessments. We suggest that such an approach would be, in the longer term, the most valuable information that could be provided, regardless of whether it supported, or challenged the historical time-series of acoustics data. The PI of this project, more than anyone else, is in a position to put many assumptions to the test – while still providing the necessary data that will provide a time-series input to the assessment model.

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PI Response:

Fish size can clearly affect target strength. Through the years, it has been imperative to capture pre-spawn herring at the time of the acoustic survey to determine average size in the population. This has been a routine part of the survey effort over the years. Some years obtaining samples has been difficult (e.g. 2015) and we have had to rely on data collected in previous years. In our original proposal, we noted that we will estimate mean size based on catches each year by ADF&G (typically a combination of purse seine and opportunistic cast net samples). Thus, we feel our monitoring effort effectively tracks changes in herring sizes to minimize any bias from interannual trends in growth and age structure of the population. We expect condition of the fish to have a relatively small effect on target strength. The size of the swimbladder is the dominant factor in defining the strength of echo returns. Depth of herring is a critical factor, but work by Thorne in the past has resulted in a sigma-correction that accounts for changes in target strength as a function of depth.

We feel the most challenging part of this survey effort is identifying the location of the fish each spring to help us plan our survey cruise. Having sufficient shiptime to accomplish this is critical, including time prior to the spawning season to look for early signs of spawning aggregations. That is why in our original proposal we included a modest number of days (5) to our field survey (this in addition to 12-14 days budgeted on the R/V Solstice in the allied proposal by Moffitt*) during the first two years of the project to assure we can meet our objectives. Due to budget limitations, we were unable to extend this during years 3-5, and thus may need to rely on other funds to support it.*

No changes were made regarding this in the revised proposal.

Appendix C

EVOSTC FY17-FY21 INVITATION FOR PROPOSALS
PROGRAM PROJECT PROPOSAL SUMMARY PAGE

Project Title

Adult Pacific Herring Acoustic Surveys in Prince William Sound

Primary Investigator(s) and Affiliation(s)

Peter S. Rand, PWSSC

Date Proposal Submitted

12 August 2016

Project Abstract

We propose to continue a long term data set of biomass estimates of the spawning population of Pacific herring in Prince William Sound. This proposal primarily addresses Objectives 1 (expanding and testing the herring ASA model) and 2 (providing input to the ASA model). Since 1993, the Prince William Sound Science Center (PWSSC) has been carrying out acoustic surveys as a cost-effective approach to estimate the biomass of adult Pacific herring just prior to the spawning period. Here we propose to continue this sampling for the next 5 years. **Our main goal for this proposed project is to produce a reliable estimate of adult biomass of the spawning population of Pacific herring for each year during 2017-2021 in support of the age-structured assessment (ASA) model**

Prince William Sound herring stock biomass estimates from hydroacoustic surveys provide a measure of the stock abundance for use in the ASA model that is the forecasting tool used for management. Prior to 2001, the hydroacoustic surveys were conducted exclusively by the Prince William Sound Science Center (PWSSC). Since 2001, the effort has been shared between PWSSC and the Cordova office of Alaska Department of Fish and Game (ADF&G). While the ADF&G considers the hydroacoustic surveys to be critical (Steve Moffitt, pers. comm.) the lack of a commercial herring fishery in PWS since 1998 has reduced management priorities for herring. Thus the PWSSC contribution has become critically important for the long-term, especially if a future fishery appears only a remote possibility. With the level of effort available over the past several years, PWSSC and ADF&G individually have achieved herring biomass estimates with a precision of about ±30%. As in recent years, we intend to continue to survey the two main spawning aggregation regions (Port Gravina and Fidalgo, and along the northeast coast of Montague Island). This will allow us to continue generating accurate estimates of the total herring spawning biomass in PWS and provide an alert to changes in biomass in these two different regions. Beginning in FY2017 and continuing through 2021, hydroacoustic surveys will be conducted in spring (March-April) to assess adult spawning biomass. This project will use the ADF&G data from direct sampling for age, sex and length in the estimates of biomass. The estimate will then be provided to the modeling project.

EVOSTC Funding Requested *(must include 9% GA)*

FY17	FY18	FY19	FY20	FY21	TOTAL
$74.2	$73.8	$61.3	$63.1	$64.9	$337.4

Non-EVOSTC Funding Available

FY17	FY18	FY19	FY20	FY21	TOTAL

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Please refer to the Invitation for the specific proposal requirements for each Focus Area. The information requested in this form is in addition to the information requested in each Focus Area and by the Invitation.

1. Executive Summary

Identify the hypotheses the project is designed to address. Describe the background and history of the problem. Include a scientific literature review that covers the most significant previous work history related to the project. Please provide a summary of the project including key hypotheses and overall goals.

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the Exxon Valdez Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). The current proposal will extend a long term data set on adult herring biomass which serves as a leading indicator of species recovery in PWS.

The current management of the Prince William Sound (PWS) herring stock by the Alaska Department of Fish and Game (ADF&G) includes information from hydroacoustic surveys. Biomass estimates from these surveys provide a measure of the stock abundance and serves as input into the age-structured assessment (ASA) model that is the primary forecasting tool. The hydroacoustic surveys were initiated in 1993 when fishers were unable to locate concentrations of herring despite a forecast for high abundance. Over time the hydroacoustic survey has shown to be an early and relatively precise measure of the herring stock abundance and compares well with the recent ASA model estimates that now can incorporate hydroacoustic survey information.

Prior to 2001, the hydroacoustic surveys were conducted exclusively by the Prince William Sound Science Center (PWSSC). Since 2001, the effort has been shared between PWSSC and the Cordova office of Alaska Department of Fish and Game. Over the past 5 years, the PWSSC effort has been supported by EVOS TC. The cooperative effort has been critical since both PWSSC and ADF&G have limited resources for this effort. While ADF&G considers the hydroacoustic surveys to be critical (Steve Moffitt, personal communication) the lack of a commercial herring fishery in PWS since 1998 has reduced management priorities for herring during a time of overall limited funding for the state agency. Thus the PWSSC contribution has become critically important for the long-term, especially if a future fishery appears only a remote possibility. With the level of effort available over the past several years, PWSSC has achieved herring biomass estimates with a precision of about ±30%.

Here we propose to extend this monitoring effort for 5 years (2017-2021). Our main goal is to estimate biomass of the spawning population of Pacific herring in Prince William Sound. Through an integrated program involving hydroacoustics and direct capture of herring, we will produce a reliable estimate of biomass to be used in the ASA model. We will maintain a similar level of survey effort relative to the combined surveys of PWSSC and ADF&G conducted in the past. The inter-annual trend in our biomass estimate will be compared to miles-spawn (see ADF&G proposal) to help determine the degree of coherence between these two measures of the size of the spawning population in Prince William Sound. Having two concurrent efforts at monitoring the spawning population can provide assurance that we will be able to detect marked changes in the status of this population given the uncertainties associated with field work in this region. After each survey, we will provide detailed summaries of the cruise and results of our survey, including a biomass estimate and any indications of interannual trends in spatial distribution of herring. Annual reports from past years will also be available through the AOOS data portal.

2. Relevance to the Invitation for Proposals

Discuss how the project addresses the projects of interest listed in the Invitation and the overall Program goals and objectives. Describe the results you expect to achieve during the project, the benefits of success as they relate to the topic under which the proposal was submitted, and the potential recipients of these benefits.

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The present proposal directly addresses objective #3 of the EVOS HRM: 3) Provide input into the stock assessment model. Biomass estimates of the spawning population is a critical input into the model. This proposed work will generate estimates for the adult spawning biomass during each year of the grant period (2017-2021).

We expect to produce a robust times series (5 years) of spawning population biomass that will extend a time series begun in the 1990s. Through our efforts we will also be able to monitor significant spatial shifts in the spawning habitat, and this may provide insight into how these fish are coping with climate change and related oceanographic conditions.

If we detect a significant recovery of this species, fishers in this region would clearly benefit if the status of herring improves to the point that it could sustain some level of exploitation. Our work could also provide important insight into food web and ecosystem dynamics of the Prince William Sound region. Pacific herring play a critical role in this ecosystem, both as predator and prey, and better understanding their dynamics can help understand how the ecosystem may change in the future.

3. Project Personnel

The CV's of all principal investigators and other senior personnel involved in the proposal must be provided. Each resume is limited to two consecutively numbered pages and must include the following information:

- A list of professional and academic credentials, mailing address, and other contact information (including e-mail address)
- A list of up your most recent publications most closely related to the proposed project and up to five other significant publications. Do not include additional lists of publications, lectures, etc.
- A list of all persons (including their organizational affiliations) in alphabetical order with whom you have collaborated on a project or publication within the last four years. If there have been no collaborators, this should be indicated.

Appendix C

Peter S. Rand, Ph.D.

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Education

Colgate University, Biology, B.A., 1987

SUNY College of Environmental Science and Forestry, Ecology, M.S., 1990

SUNY College of Environmental Science and Forestry, Ecology, Ph.D., 1994

University of British Columbia, Fisheries Science, Postdoctoral Fellow, 1995-1997

Professional Positions

Research Ecologist, Prince William Sound Science Center (2015-present)

Senior Conservation Biologist (2003-2015), Wild Salmon Center.

Assistant Professor (1997–2003), Department of Zoology, North Carolina State University.

Research Interests

Ecological studies of freshwater, anadromous and marine fishes. Modeling studies of migration, energetics, survival and population dynamics. Novel field applications involving sonar and video methods to increase understanding of abundance, distribution, foraging, swimming behavior and predator-prey interactions.

Select Publications

Rand, P.S., and M. Fukushima. 2014. Estimating the size of the spawning population and evaluating environmental controls on migration for a critically endangered Asian salmonid, Sakhalin taimen. Global Ecology and Conservation 2:214-225.

Taylor, J.C., **P.S. Rand**, and J. Jenkins. 2007. Swimming behavior of juvenile anchovies (*Anchoa* spp.) in an episodically hypoxic estuary: implications for individual energetics and trophic dynamics. Mar. Biol. 152(4):939-957.

Rand, P.S., J.C. Taylor, and D.B. Eggleston. 2006. A stereo-video method for quantifying size distribution, density and three-dimensional spatial structure of reef fish spawning aggregations. National Marine Fisheries Service Professional Paper Series 5: 4-9.

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Taylor, J.C., D.B. Eggleston, and **P.S. Rand**. 2006. Nassau grouper (Epinephelus striatus) spawning aggregations: hydroacoustic surveys and geostatistical analysis. National Marine Fisheries Service Professional Paper Series 5: 18-25.

Taylor, J.C., J.S. Thompson, **P.S. Rand**, and M. Fuentes. 2005. Sampling and statistical considerations for hydroacoustic surveys used in estimating abundance of forage fishes in reservoirs. North Am. J. Fish. Mgmt. 25: 73-85.

Taylor, J.C., and **P.S. Rand**. 2003. Spatial overlap and distribution of anchovies (*Anchoa* spp.) and copepods in a shallow stratified estuary. Aquat. Living Resour. (Elsevier, France) - Special ICES Volume 16: 191-196.

Rand, P.S. and S.G. Hinch. 1998. Spatial patterns of zooplankton biomass in the Northeast Pacific Ocean. Mar. Ecol. Prog. Ser. 171:181-186.

Rand, P.S., D.J. Stewart, B.F. Lantry, L. Rudstam, O.E. Johannsson, A. Goyke, S.B. Brandt, R. O'Gorman, G.W. Eck. 1995. Effect of lake-wide planktivory by pelagic prey fishes in Lakes Michigan and Ontario. Can. J. Fish. Aquat. Sci. 52:1546-1563.

Other Publications

Rand, P.S., B.A. Berejikian, T.N. Pearsons, and D.L.G. Noakes. 2012. Ecological interactions between wild and hatchery salmonids: an introduction to the special issue. Environmental Biology of Fishes. DOI 10.1007/s10641-012-9987-3

Rand, P.S., M. Goslin, M.R. Gross, J.R. Irvine, X. Augerot, et al. 2012. Global assessment of extinction risk to populations of sockeye salmon Oncorhynchus nerka. PLoS ONE 7(4): e34065. doi:10.1371/journal.pone.0034065

Zimmerman, C.E., **P.S. Rand**, M. Fukushima, and S.F. Zolotukhin. 2011. Reconstructing migratory and growth histories of Sakhalin taimen (*Parahucho perryi*). Environmental Biology of Fishes DOI 10.1007/s10641-011-9908-x

Rand, P.S., S.G. Hinch, J. Morrison, M.G.G. Foreman, M.J. MacNutt, J.S. Macdonald, M.C. Healey, A.P. Farrell, and D.A. Higgs. 2006. Effects of changes to river discharge, temperature and future climate on energetics and mortality of adult migrating Fraser River sockeye salmon. Transactions of the American Fisheries Society. 135:655-667.

Rand, P.S. 2002. Modeling stomach fullness and growth potential of sockeye salmon in the Gulf of Alaska: Implications for high seas distribution and migration. Mar. Ecol. Prog. Ser. 234:265-280.

Collaborators

Hitoshi Araki (Hokkaido University), Barry Berijikian (NOAA), K. Boswell (FIU), S. Cooke (CarletonU), Michio Fukushima (NIES), K. Gorman (PWSSC), Mart Gross (UToronto), Jim Irvine (DFO), E. Knudsen (Independent Contractor), David Noakes (Oregon State University), Dmitry Pavlov (Moscow State University), Todd Pearsons (Grant County PUD), Richard Thorne (PWSSC), Lev Zhivotovsky (Russia Academy of Sciences), Christian Zimmerman (USGS), Sergei Zolotukhin (TINRO)

4. Project Design

A. Objectives

List the objectives of the proposed research and briefly state why the intended research is important. If your proposed project builds on recent work, provide detail on why the data set needs to be continued and whether

any changes are proposed. If the proposed project is for new work, explain why the new data is needed. Describe the anticipated final product.

B. Procedural and Scientific Methods

For each objective listed in A. above, identify the specific methods that will be used to meet the objective. In describing the methodologies for collection and analysis, identify measurements to be made and the anticipated precision and accuracy of each measurement and describe the sampling equipment in a manner that permits an assessment of the anticipated raw-data quality.

If applicable, discuss alternative methodologies considered, and explain why the proposed methods were chosen. In addition, projects that will involve the lethal collection of birds or mammals must comply with the EVOSTC's policy on collections, available on our website www.evostc.state.ak.us

C. Data Analysis and Statistical Methods

Describe the process for analyzing data. Discuss the means by which the measurements to be taken could be compared with historical observations or with regions that are thought to have similar ecosystems. Describe the statistical power of the proposed sampling program for detecting a significant change in numbers. To the extent that the variation to be expected in the response variable(s) is known or can be approximated, proposals should demonstrate that the sample sizes and sampling times (for dynamic processes) are of sufficient power or robustness to adequately test the hypotheses. For environmental measurements, what is the measurement error associated with the devices and approaches to be used?

D. Description of Study Area

Where will the project be undertaken? Describe the study area, including, if applicable, decimally-coded latitude and longitude readings of sampling locations or the bounding coordinates of the sampling region (e.g., 60.8233, -147.1029, 60.4739, -147.7309 for the north, east, south and west bounding coordinates).

Objectives

Our main goal for this proposed project is to produce a reliable estimate of adult biomass of the spawning population of Pacific herring for each year during 2017-2021 in support of the age-structured assessment (ASA) model. In support of this goal, we identify the following objectives:

1) Carry out a hydroacoustic survey prior to the herring spawning season as a means to quantify the total biomass of adult herring in regions within Prince William Sound that have historically been important for spawning. This survey includes validation of targets by direct capture of fish with various gear types.
2) Each year conduct repeated hydroacoustic sampling over transects to quantify precision of our biomass estimates.
3) Carry out reconnaissance by air or ship to assure our survey design is adapting to any changes in the spawning distribution of Pacific herring in PWS.

Procedural and Scientific Methods

The general use of acoustic methods for fisheries assessment is described in several publications including Simmonds and MacLennan (2005), Taylor et al. (2005), and Rudstam et al. (2013). Applications to Pacific herring are well documented (Thorne 1977a,b; Trumble et al. 1983).

The major difference in the Prince William Sound surveys compared to typical acoustic assessment surveys is the use of a three-stage adaptive sampling methodology rather than systematic transects. Adult herring during the extended winter period in PWS are typically located in a few select bays and inlets and are distributed primarily in

large mid-water schools or dense layers at night. The surveys are conducted during the late winter/early spring pre-spawning distribution when the herring are most concentrated. The initial survey stage focuses on the location of these adult herring aggregations within PWS. Approaches include aerial surveys of foraging marine mammals, especially Steller sea lions and humpback whales, sonar surveys and observations from fishers, hunters and others transiting PWS, as well as a database of historic locations. After the herring are located, the second stage consists of multiple echo integration surveys over the areas occupied by the herring schools. These surveys are generally conducted at night with a dark vessel since herring are further removed from bottom at night, but are very light sensitive. The multiple surveys are used to determine the precision of the biomass estimates. The focus on pre-spawning herring also simplifies species composition problems as the concentrations are virtually all adult herring.

Currently the PWSSC has digital echosounder systems that are well-matched to our needs. Our echosounders are DTX BioSonics systems (www.biosonicsinc.com/product-dtx-portable-echosounder.asp). We have two digital transducers that are capable of meeting our survey needs: a single-beam 70 kHz transducer, and a split-beam 120 kHz transducer. While the former is not capable of determining position of targets off the axis beam, it can be used to produce reliable biomass estimates through echointegration. This is the unit that has been used in the PWS surveys since 2002 (R. Thorne, pers. comm.). In 2012 the PWSSC acquired a split-beam 120 kHz DTX system, and we propose that this unit will be our primary echosounder for this survey. This system assures a more accurate calibration in the field, and can be used to track individuals through the beam, providing an opportunity for some additional insight into fish movement and behavior. We propose to run them simultaneously to compare their performance and assure consistency in this long-term data series. Further, having two systems allows us to conduct independent surveys off two separate vessels.

Figure 1. Examples of typical, zig-zag transects in Fidalgo and Gravina Bays in eastern Prince William Sound. The locations of these transects in any given year are based on plane and ship reconnaissance to determine the distribution of the spawning population.

After the echo integration surveys, the herring schools are sub-sampled for biological information, primarily with a commercial purse seine (see ADF&G proposal). To augment this, we will opportunistically sample herring with other gear, including multi-panel gillnets and castnets. The size composition of the herring in the net catches is used to estimate target strengths for converting backscatter to biomass (see below for specific methods). While the acoustic surveys were initiated by PWSSC, the survey effort has been conducted in cooperation with Alaska Department of Fish & Game (ADFG) for most of its history. ADFG has conducted most of the direct capture sampling for age/weight/length. ADFG began to conduct acoustic surveys as well in 2001. From 2001-2004 both institutions collected acoustic data, all of which were analyzed by PWSSC. Since 2005, ADFG acoustic surveys have been conducted independently. For the proposed grant period, we intend to conduct the survey in cooperation with ADF&G (14 days, budgeted in the ADF&G proposal), in addition to 5 additional days we have budgeted in Years 1 & 2. This extra shiptime will allow us to charter a separate vessel for reconnaissance and additional survey work

to help us evaluate any shifts in the spawning distribution relative to historical surveys. This level of effort is comparable to the combined survey effort in the past from PWSSC and ADF&G.

Data analysis and statistical methods

The methods used in PWS are detailed in several publications, including Thomas et al. (1997), Thomas and Thorne (2003) and Thorne and Thomas (2008). They are similar to standard methods in most regards: a single frequency system, down-looking transducer orientation, towed vehicle, echo integration signal processing, biological sampling for species and size information and calibration with standard targets. The transect design has been a zig-zag pattern along the shoreline. The target strength relationship that is used to scale echo integration was derived from many years of experience that culminated in the ex-situ target strength measurements described in Thomas et al. (2002). We propose to continue the survey as described. The PI of the current proposal has been working closely with Richard Thorne to assure the methods and overall approach will remain consistent with past surveys. We propose to carry out analyses using the Biosonics echointegration software used by R. Thorne to assure consistency. In addition, we propose to analyze data with a newer software program, Echoview (Version 5.4), and determine if there are advantages and efficiencies to be gained by using this newer software for our biomass estimation. Below we describe the analytical steps in arriving at a biomass estimate.

Target strengths measured by the echosounder need to be converted to biomass. Here we propose to follow the approach described in Thorne (1981). A number of studies have concluded that the function is non-linear, and reflects the fact that smaller fish reflect slightly more energy per unit of biomass compared to larger fish. Thorne (1981) incorporated multiple data sources into a single length-dependent relationship as follows:

$$TS_w = -5.98\text{Log}(L) - 24.23$$

where TS_w is the target strength (decibels) per unit weight, w is weight in kg and L is standard length of herring in cm. Lengths of fish will be determined by direct capture (see ADF&G proposal).

Ex situ target strength measurements were conducted on herring in Prince William Sound (Thomas et al 2002). The research verified the relationship described from Thorne (1981), but added depth and seasonal effects that resulted from swim bladder compression and gonad development. The Thorne (1981) relationship was found to be accurate for spring (prespawning) herring at 40 m depth, a reasonable depth assumption for night herring distributions. However, day distributions are much deeper, often over 100 m. Consequently, a depth correction for the target strengths has been applied to PWS herring surveys beginning in 2008 when daytime surveys began to be included in the survey effort. While we do not intend to survey during the day during this grant period, we will make adjustment in the analysis to account for changes in depth across the survey area (see below for additional details).

It is important to quantify the precision of our biomass estimates, and identify sources of error. The variance associated with the estimate has been approximated using the Delta Method (Oehlert 1992; Casella and Berger 2002). For purposes of the calculation, each series is divided into two estimates of herring biomass by separating the zigs from the zags in the transect survey to assure independence, thus producing two parallel series. These are combined with multiple surveys on the same population producing n values that can range from 2 to 8 biomass estimates depending on the opportunity for repeated surveys. Data from the estimates are not transformed. Variance of the total population is the sum of variances of the individual areas.

Based on previous sampling involving replicate sampling of transects during the spring survey, it was estimated that error in biomass estimates is ~30% (R. Thorne, pers. comm.). Assuming a 30% coefficient of variation, we determined the relationship between the number of years of acoustic sampling and the effect size (i.e. proportional changes in biomass) we can discern over time (at $\alpha = \beta = 0.05$, after Gerrodette 1987). After 5 years of sampling, we would be able to discern ~34% change in biomass (Fig. 2). We feel this level of power to detect trends is

adequate to achieve our overall goal of detecting a recovery of herring in PWS and providing reliable annual data as input into the ASA model. By repeatedly sampling the same transects during our cruises each year, we will be able to quantify changes in precision in our sampling. Our objective is to maintain this level of sampling precision during this grant period.

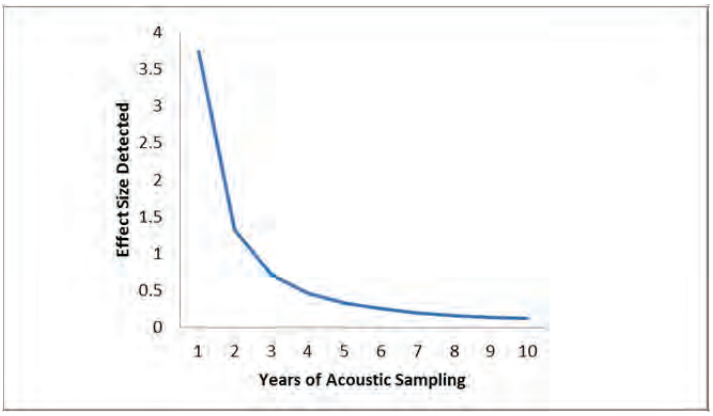

Figure 1. The effect size (i.e. the magnitude of interannual changes in abundance of adult Pacific herring) we can discern given the error associated in the hydroacoustic survey estimates.

It is important to document important sources of error in our biomass estimation. There are limitations in the habitat that can be effectively sampled using hydroacoustics. There is a blind spot near field (approximately 1 m away from the face of the transducer) and far field (approximately 1 m off bottom) that may contribute to an underestimate of biomass along a sampled transect. Herring generally are not surface oriented, so we do not believe lack of sampling at the surface is a significant source of error. Further, we minimize the error associated with missing fish on the bottom by sampling at night, a period where fish generally migrate off the bottom.

The accuracy of echointegration is a function of the school density of herring in the water column. In conditions of tightly packed schools, fish that are located near the bottom of the school may be in an acoustic shadow and thus their contribution to total backscatter may be reduced. We reduce this error by conducting our acoustic surveys at night, a period when fish are more dispersed in the water column.

The parameters used in our echointegration (particularly σ_{bs}, the acoustic backscattering cross section for a single target, in units m^2, as in McLennan et al. 2002) are associated with some error. We intend to account for two factors that are known to affect this parameter, specifically depth and season. Thomas et al. (2002) documents how σ_{bs} changes as a function of depth and season. As in previous years, we intend to account for this in the analysis of our survey data, following the current protocol (R. Thorne, pers. comm.). For each region sampled, we will adjust the σ_{bs} to best match the depth distribution of fish, and we will apply the appropriate parameter for sampling in the spring. Fish orientation in the water column can also affect σ_{bs}, but sampling primarily along the dorsal aspect of the fish, with the transducer downlooking into the water column, is known to reduce this error.

While we will be conducting routine species validation of our acoustic surveys, another source of error is the inclusion of other species along our sampling transects. Based on past experience, we have high confidence that the schools we sample are comprised entirely of Pacific herring. Our direct capture effort will continue to serve as a check on this assumption, but, in general, we feel this is a negligible source of error in our biomass estimates.

A key assumption in the power analysis described above is that our acoustic surveys are covering the habitat occupied by spawning herring during the spring. As described in our methods, we will endeavor to distribute sampling effort to adequately sample the entire PWS spawning population. Climate change can profoundly change the Prince William Sound ecosystem. We expect that herring life history may show some dramatic change in the

coming years. This monitoring effort is intended to be adaptive given these changing environmental conditions. We have budgeted for additional shiptime support during the first two years of the project (in addition to the 14 days budgeted in the ADF&G proposal during 2017-2021) to enable some expanded sampling coverage and provide opportunities for simultaneous surveys (either in the same region to provide additional replicate sampling, or conducted independently in different regions). This will improve our ability to detect any temporal or spatial changes that may take place during the coming years and help us meet our broader goals and objectives.

Description of study area

We propose to sample along the north coast of Montague Island and the Port Gravina/Fidalgo area. Based on patterns we observe over the course of this monitoring effort, we may adapt the survey area to assure we conduct a comprehensive survey of the spawning population.

5. Coordination and Collaboration

Within the Program

Provide a list and clearly describe the functional and operational relationships with the other program projects. This includes any coordination that has taken or will take place and what form the coordination will take (shared field sites or researchers, research platforms, sample collection, data management, equipment purchases, etc.).

With Other EVOSTC-funded Programs and Projects

Indicate how your proposed program relates to, complements or includes collaborative efforts with other proposed or existing programs or projects funded by the EVOSTC.

With Trustee or Management Agencies

Please discuss if there are any areas which may support EVOSTC trust or other agency work or which have received EVOSTC trust or other agency feedback or direction, including the contact name of the agency staff. Please include specific information as to how the subject area may assist EVOSTC trust or other agency work.

If the proposed project requires or includes collaboration with other agencies, organizations or scientists to accomplish the work, such arrangements should be fully explained and the names of agency or organization representatives involved in the project should be provided. If your proposal is in conflict with another project or program, note this and explain why.

With Native and Local Communities

Provide a detailed plan for any local and native community involvement in the project.

Our proposal is closely aligned with the spring spawning survey proposal of ADF&G. The majority of the shiptime for our acoustic surveys is included in this allied proposal. Further, the ASL sampling (required to partition our total biomass estimate into separate age classes) is included in this allied proposal.

Data we generate in our proposed field work will also support the ASA model analyses in Trevor Branch's UW proposal.

Movements of herring determined by the proposed HRM tagging program may inform our survey planning during this grant period. Understanding movements of adult fish during the spring will help us address issues implicit in our survey design. Understanding residence time of adult herring in the spawning areas, and their migratory patterns between PWS and the Gulf of Alaska could help improve our ability to monitor the spawning population.

Appendix C

6. Schedule

Program Milestones

Specify when critical program tasks will be completed. Reviewers will use this information in conjunction with annual program reports to assess whether the program is meeting its objectives and is suitable for continued funding.

Measurable Program Tasks

Specify, by each quarter of each fiscal year (February 1 – January 31), when critical program tasks will be completed.

Task	FY17				FY18				FY19				FY20				FY21			
	EVOSTC FY Quarter (beginning Feb. 1)																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Task 1 admin & logistics																				
Contracting for shiptime	X				X															
permitting	X				X				X				X				X			
Task 2 data acquisition & processing																				
Research Cruise	X				X				X				X				X			
Post processing			X				X				X				X			X	X	
Task 3 data management																				
database mgmt./QAQC			X				X				X				X				X	
metadata (HRM)			X				X				X				X				X	
workspace upload			X				X				X				X				X	
Task 4 analysis & reporting																				
Analysis and summary				X				X				X				X				X
Annual Reports					X				X				X				X			X
Annual PI meeting				X				X				X				X				X
Permit reports				X				X				X				X				X

7. Budget

Budget Forms (Attached)

Please provide completed budget forms. Please note that the following items will not be considered for funding:

- Costs associated with international travel for meetings, symposia, or presentations.
- Costs associated with attendance at meetings, symposia, or presentations outside of those required to coordinate with project members.
- Costs associated with outreach or education efforts.

Sources of Additional Funding

Identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

References

Appendix C

Casella, G. and Berger, R. L. 2002. Statistical Inference, 2nd ed.

Gerrodette, T. 1987. A power analysis for detecting trends. Ecology 68(5):1364-1372.

MacLennan, D. N., and E.J. Simmonds 1992. Fisheries Acoustics. Chapman and Hall, London, 325p.MacLennan, P.G. Fernandes, and J. Dalen. 2002. A consistent approach to definitions and symbols in fisheries acoustics. ICES Journal of Marine Science 59:365-369.

Oehlert, G. W. 1992. A Note on the Delta Method, The American Statistician, Vol. 46, No. 1, p. 27-29.

Rudstam, L.G., J. Michael Jech, Sandra L. Parker-Stetter, John K. Horne, Patrick J. Sullivan, and Doran M. Mason. 2013. Fisheries Acoustics. In Zale, A.V., D.L. Parrish, and T.M. Sutton (Eds), Fisheries techniques, 3rd Edition. American Fisheries Society

Simmonds, J. and D. MacLennon 2005. Fisheries Acoustics: theory and practice, 2nd Ed.. Blackwell Science, 429 p

Taylor, J. C., J. S. Thompson, P. S. Rand, and M. Fuentes. 2005. Sampling and statistical considerations for hydroacoustic surveys used in estimating abundance of forage fishes in reservoirs. North American Journal of Fisheries Management 23:75–83.

Thomas, G.L., E.V. Patrick, Jay Kirsch and J.R. Allen. 1997. Development have and ecosystem model for managing the fisheries resources of Prince William Sound, Alaska. Proceedings of the 2nd World Fisheries Congress. Ed (D.A. Hancock, D.C. Smith, A. Grant, and J.P Beumer. CSIRO. Collingwood. Pages 606-614.

Thomas, G.L, J. Kirsch and R.E. Thorne 2002. Ex situ target strength measurements of Pacific herring and Pacific sand lance, North American Journal of Fisheries Management 22:1136-1145.

Thomas, G. L. and Thorne, R.E. 2003. Acoustical-optical assessment of Pacific herring and their predator assemblage in Prince William Sound, Alaska. Aquatic Living Resources 16:247-253.

Thorne, R.E. 1977a. Acoustic assessment of hake and herring stocks in Puget Sound, Washington and southeastern Alaska. Pp. 265-278 in A.R. Margets (ed), Hydroacoustics in Fisheries Research. ICES Rapp. Et P.-v., Vol 170.

Thorne, R.E. 1977b. A new digital hydroacoustic data processor and some observations on herring in Alaska. J. Fish. Res. Bd. Canada 34:2288-2294.

Thorne, R.E. and G.L. Thomas 2008. Herring and the “Exxon Valdez” oil spill: an investigation into historical data conflicts. ICES Journal of Marine Science 65(1):44-50.

Trumble, R., R.E. Thorne and Lemberg 1983. The Strait of Georgia herring fishery: A case history of timely management aided by hydroacoustic surveys. Fisheries Bulletin 80(2):381-388.

Appendix C

Budget Justification

1. **Personnel.** We request support for 3 mo/yr for the PI to lead the project, including managing grant funds, arranging contracts, participating in field work, analyzing data and reporting results into reports and scientific manuscripts. We request support for a research technician at 0.5 mo/yr to assist in preparing and carrying out the field work during the spring cruise.
2. **Travel.** Travel funds are requested for the PI to attend annual PI meeting. Include is 1 round trip air fare or ferry service to meeting venue, and 2 days lodging and per diem.
3. **Contractual.** We request support during Years 1 & 2 for shiptime for additional reconnaissance and acoustic sampling. This additional shiptime (above the amount included in the allied proposal of ADF&G) provides an opportunity to survey a broader region and provide more opportunities for replicate transect sampling. In addition, we budget for communications at PWSSC for phone and email services, and use of PWSSC vehicles for transport of people and gear in Cordova.
4. **Commodities.** We request support during Year 1 for one PC for acoustic data analysis.
5. **Indirect Rate.** We apply the PWSSC indirect rate of 30%.

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Budget Category:	Proposed FY 17	Proposed FY 18	Proposed FY 19	Proposed FY 20	Proposed FY 21	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$39.5	$40.7	$41.9	$43.2	$44.5	$209.9	
Travel	$0.6	$0.6	$0.6	$0.6	$0.6	$2.8	
Contractual	$10.8	$10.8	$0.8	$0.8	$0.8	$24.0	
Commodities	$1.5	$0.0	$0.0	$0.0	$0.0	$1.5	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	
Indirect Costs (*will vary by proposer*)	$15.7	$15.6	$13.0	$13.4	$13.8	$71.4	
SUBTOTAL	$68.1	$67.7	$56.3	$57.9	$59.6	$309.5	
General Administration (9% of	$6.1	$6.1	$5.1	$5.2	$5.4	$27.9	N/A
PROJECT TOTAL	$74.2	$73.8	$61.3	$63.1	$64.9	$337.4	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	

COMMENTS:
This summary page provides an five-year overview of proposed project funding and actual cumulative spending. The column titled 'Actual Cumulative' must be updated each fiscal year as part of the annual reporting requirements. Provide information on the total amount actually spent for all completed years of the project. On the Project Annual Report Form, if any line item exceeds a 10% deviation from the originally-proposed amount; provide detail regarding the reason for the deviation.

FY17-21

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

NON-TRUSTEE AGENCY SUMMARY PAGE

Date Prepared: 08/24/2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Peter S. Rand	Adult Pacific Herring Acoustic Surveys	3.0	12.3		36.9
Research Assistant	Adult Pacific Herring Acoustic Surveys	0.5	5.3		2.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	17.6	0.0	
				Personnel Total	$39.5

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Trip to annual PI meeting	0.3	1	2	0.2	0.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.6

FY17

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08/24/2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Contractual Costs: Description	Contract Sum
Shiptime (5 days @$2000/day)	10.0
PWSSC communications (3.5 person-months @ $140/month)	0.5
Vehicle and fuel	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$10.8

Commodities Costs: Description	Commodities Sum
PC for Acoustic Analysis	1.5
Commodities Total	$1.5

FY17

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: 08/24/2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY17

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
EQUIPMENT DETAIL

Date Prepared: 08/24/2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Peter S. Rand	Adult Pacific Herring Acoustic Surveys	3.0	12.7		38.0
Research Assistant	Adult Pacific Herring Acoustic Surveys	0.5	5.4		2.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	18.1	0.0	
				Personnel Total	$40.7

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Trip to annual PI meeting	0.3	1	2	0.2	0.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.6

FY18

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08/24/2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Contractual Costs: Description	Contract Sum
Shiptime (5 days @$2000/day)	10.0
PWSSC communications (3.5 person-months @ $140/month)	0.5
Vehicle and fuel	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$10.8

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY18

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: 08/24/2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY18

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
EQUIPMENT DETAIL

Date Prepared: 08/24/2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Peter S. Rand	Adult Pacific Herring Acoustic Surveys	3.0	13.1		39.2
Research Assistant	Adult Pacific Herring Acoustic Surveys	0.5	5.6		2.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	18.6	0.0	
				Personnel Total	$41.9

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Trip to annual PI meeting	0.3	1	2	0.2	0.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.6

FY19

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08/24/2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Contractual Costs: Description	Contract Sum
PWSSC communications (3.5 person-months @ $140/month)	0.5
Vehicle and fuel	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.8

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY19

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: 08/24/2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY19

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
EQUIPMENT DETAIL

Date Prepared: 08/24/2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Peter S. Rand	Adult Pacific Herring Acoustic Surveys	3.0	13.4		40.3
Research Assistant	Adult Pacific Herring Acoustic Surveys	0.5	5.7		2.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	19.2	0.0	
				Personnel Total	$43.2

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Trip to annual PI meeting	0.3	1	2	0.2	0.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.6

FY20

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08/24/2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Contractual Costs: Description	Contract Sum
PWSSC communications (3.5 person-months @ $140/month)	0.5
Vehicle and fuel	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.8

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY20

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: 08/24/2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY20

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
EQUIPMENT DETAIL

Date Prepared: 08/24/2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Personnel Costs:		Months	Monthly		Personnel
Name	Project Title	Budgeted	Costs	Overtime	Sum
Peter S. Rand	Adult Pacific Herring Acoustic Surveys	3.0	13.8		41.5
Research Assistant	Adult Pacific Herring Acoustic Surveys	0.5	5.9		3.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
		Subtotal	19.8	0.0	
				Personnel Total	$44.5

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
Trip to annual PI meeting	0.3	1	2	0.2	0.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.6

FY21

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
PERSONNEL & TRAVEL DETAIL

Date Prepared: 08/24/2016

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

Contractual Costs: Description	Contract Sum
PWSSC communications (3.5 person-months @ $140/month)	0.5
Vehicle and fuel	0.3
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.8

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY21

Project Title: Adult Pacific Herring Acoustic Surveys
Primary Investigator: Peter S. Rand

FORM 3B
CONTRACTUAL & COMMODITIES DETAIL

Date Prepared: 08/24/2016

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM PROJECT BUDGET PROPOSAL AND REPORTING FORM

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY21	**Project Title: Adult Pacific Herring Acoustic Surveys** **Primary Investigator: Peter S. Rand**	**FORM 3B** **EQUIPMENT DETAIL**

Date Prepared: 08/24/2016